

THE NATURAL HISTORY OF *CALOTES VERSICOLOR*
(BOULENGER), THE COMMON BLOOD-SUCKER.

BY

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The writer is primarily interested in the study of the formation and development to maturity of the reproductive or germ cells in animals and in the study of the problem as to whether these germ cells segregate or separate themselves off very early from other somatic or body cells in the embryonic history of animals. As Weismann thought, this is a problem which has a significant bearing on the Theory of Heredity.

With that object in view, during the last five years, his efforts have been mainly directed to studying the breeding habits, the egg-laying period, and in obtaining accurately timed and closely graded embryonic series in the developmental stages of this lizard, which is fairly common in the environs of Ahmedabad. The following observations may perhaps interest the readers of our *Journal* and we hope that these will be supplemented in the course of time by the students of Natural History in this or other part of the country.

Kelaart (1852), Gunther (1864), Murray (1884), and Boulenger refer to this common Indian Lizard in their works, which are mainly concerned with the identification and classification of animals. They give none or few details regarding the habits of this lizard. So far as the writer is aware, a more or less detailed account of the breeding habits, the egg-laying period, the period of the incubation of the eggs and the attainment of sexual maturity by the developing young and the seasonal variations in the testes and ovaries has not yet been published in this country.

For determining the generic and specific characters, colouration, etc., the interested student may refer to the works of the writers, above mentioned. However, we may mention in passing that these lizards are quite harmless creatures, not difficult to capture. As regards size, though Boulenger records the average adult size around four and a half inches from snout to vent, some of our adult males measure upwards of six inches from snout to vent. Again in the first year of their life history as the young attain sexual maturity, particularly after about four to five months' growth, the disparity in body size between the sexes comes into existence and is most marked in their first breeding season, the female being decidedly smaller and slenderer in build than the male.

Though colouration is variable there are definite tracts or patterns which always appear at the same place in the process of colour change. Again, contrary to what Gunther says regarding

the difference in colouration of the throat and the snout of sexually mature and immature specimens in his work, we have observed that the characteristic colouration of the immature specimens both male and female, the dark brown narrow transverse bands across the orbital region, particularly those dark brown streaks on the lower jaw, which radiate from the ventrum of the snout to the throat are well preserved and persist even after sexual maturity is attained.

Calotes versicolor is found in cultivated and uncultivated fields, on trees, shrubs, on Euphorbia hedges and in the gardens, occurring normally throughout the year. However, these lizards are not so commonly met with from about the middle of November till the end of February. It is likely that in regions which are more sandy and dry as Ahmedabad, and which are more cold in the dry season in India, these lizards, if they do not actually hibernate, undergo a periodic inactivity, a cold weather torpor, moving little in search of food. The following observations made by Mr. McCann of the Bombay Natural History Society in a neighbouring tract, Rajputana, may perhaps lend support to this view: '*Calotes versicolor* is very common in Rajputana during the hot and rainy weather, but it is conspicuously absent in the winter. I have found these lizards during the winter months sheltering in disused chimneys, behind cloth curtains, and even in dirty clothes baskets. When disturbed they are comparatively slow in their movements and will soon return to their place of shelter in spite of being disturbed several times. On one occasion I found two in a nest composed of tow which may have been made by squirrels, for I do not believe that these lizards are capable of constructing a nest of their own. In late February *Calotes* is once more about.'

FOOD

Many observations have not been made by us on its food habits amidst natural conditions, but an examination of the contents of the stomach of the dissected specimens frequently revealed hard or undigested parts of beetles, large and small ants, insect larvæ and wings of butterflies. While in confinement, under laboratory conditions, grown up specimens could be kept going for considerable time on such food as bits of fresh frog-liver and fat-bodies with an occasional grasshopper or butterfly. The former kind of food was often forced into their mouths. But the greatest difficulty was encountered in the direction of finding suitable food for rearing the young which hatched from the eggs. These were kept in as natural a condition as possible in the open, in a wire-netting box sunk into the earth so that natural earth may form from its bottom. Feeding them on white ants and small quantities of fresh frog-liver and fat-bodies they were kept going for about a month; only three or four specimens survived a period of a month and a half. Once they grow to be about four or five months old they would stand confinement better, and be easier to keep on such kind of food as mentioned above. Some specimens captured from the wild, which we know to be three to four months old, and which

were reared in the laboratory on this food subsequent to their capture, lived for a considerable time—for about six to seven months after the date of their capture. They did not die; they were in a healthy condition throughout and were ultimately set free.

THE BREEDING SEASON

From the observations recorded below we may reasonably infer that the reproductive activities and the egg-laying period of *Calotes versicolor* fall within a definite, well-marked part of the year. It does not start earlier than about the first or second week of May, and it ends about the first or second week of September. Observations on the periodic variations in the growth, size and appearance of the organs of reproduction, both testes and ovaries, and the microscopical examination of these organs, enabling one to determine at which stage ripe and mature germ cells appear in them are perhaps the best criteria to determine the onset and the end of the breeding season.

SEASONAL VARIATION IN THE GONADS

During the middle of the breeding season, from June to August, the testes are deep pink in colour and the shape of a regularly formed seed of ground-nut, about 17 mm. long and 9 mm. wide. From about the third or fourth week of September they begin to decrease in size. The decrease is invariable and constant. By the last of October the testes are reduced to half the maximum size, about 8 mm. long and 4 mm. in cross section. In December and January they look remarkably small as compared with their size at the height of the breeding season. By the last of January they measure not more than 2.5 mm. long and about 0.5 in thickness. This decline is most remarkable and striking. But they start increasing in size in February. During the whole of February and first two weeks of March the increase is slow. In April there is considerable activity and they seem to progress rapidly. But the most remarkable increase takes place between the third week of April and the first half of May. They reach their maximum size by the last of June. The microscopical examination of the sections of the testes reveals the fact that this externally visible remarkable increase in the growth and the activity of the gonad, particularly during the third and fourth week of April and the first two weeks of May, is consequent upon an internal activity. We find that from this stage onwards an enormous number of ripe, matured spermatozoa are being produced internally in the tubules of the testes, heralding the onset of the breeding season.

The ovaries showed the same seasonal variation in size and form, with this difference that they are so much reduced in December and January that they could scarcely be identified as being present at all. Again the ovary, as it begins to grow on the approach of the breeding season, seems to grow more steadily and to increase without that sudden spurt so characteristic of the testes. In March

the eggs in the growing ovaries look like small white pearls. Yolk deposition in the eggs begins in April. At this time they look yellow in colour. By the last week of May a fully-matured egg measures in the ovary from 10 to 12 mm. in length and from 5 to 7 mm. in thickness, and some eggs have the characteristic oblong shape even in the ovary.

The Egg-laying Period :—In our locality, the majority of females lay eggs during June, July and August, though the farthest limits for the egg-laying period one would like to put on the strength of all the observations one has made would be from about the third week of May to the second week of September. That these are probably the farthest limits is borne out by the fact above stated, that the organs of reproduction, both male and female, are not ready for functioning earlier than May and their activity declines in the third or fourth week of September.

However, the earliest specimen of a gravid female secured from the field was on June 25; though, this does not preclude the possibility of obtaining from the field such gravid females earlier in the breeding season if they are intensively searched for. In this female, when her abdomen was opened on the day she was secured, there were six, fully developed, large, shelled-eggs in a row, antero-posteriorly, in each oviduct on either side of the body. These she would have laid in ordinary course within a week at the outset.

Moreover, the above-stated observation, that the most of the egg-laying is done in June, July and August of the breeding season is also supported by our experience of collecting naturally laid clutches of eggs in the field. In the course of three or four breeding seasons the majority of the egg-nests were collected within a period lying between the second week of July and the last week of August.

The Incubation Period for the eggs :—From the observations and experiments detailed below one may reasonably infer, that in nature the young of *Calotes* hatch out of the eggs on the completion of a period of incubation lasting over six or six weeks and a half after the eggs have been deposited in earth by the mother.

In nature the eggs are laid in moist earth in a hole six to seven inches deep and may contain from eleven to twenty-three eggs. Kelaart observed five as the minimum. While eight is the maximum according to Kelaart; Gunther records sixteen. Another observation also of these authors we are unable to corroborate. These authors record that the eggs of this lizard have been found also from the hollows in trees. In over four years of collecting we have not once obtained eggs from such places. The eggs are not glued together and lie separately in the nest.

That in the course of a breeding season one female would lay more than one batch of eggs is probable. It is also probable that normally more than twelve eggs do not go to form a clutch laid at one time, though in two or three gravid lizards we operated upon in the breeding season, there were in each oviduct on either side of the body ten to eleven eggs in a row antero-posteriorly. All of these were large, fully-developed eggs ready to be laid, looking about the same as freshly laid eggs.

The shell of a newly laid egg is pure white, soft and leathery. The egg is ovoid in shape about 10 to 11 mm. long and from 4 to 5 mm. broad. The size increases as the embryo grows inside, the most rapid increase in the size of the egg taking place from the fourth to the eighteenth day of incubation. Then it does not increase appreciably. But about three days before hatching, it shows a slight additional increase in length and breadth.

Gravid females were watched and in several cases the eggs were collected soon after they were deposited. In other cases, where the females were not actually seen, though the collected clutches of eggs looked similar to those freshly laid, we had little difficulty in finding out before how long the eggs had been deposited. One or two eggs from such a clutch would be opened and the state of the embryo inside compared with that inside a freshly laid egg previously known. In the course of three or four breeding seasons a fairly large number of such clutches of eggs collected from the field were brought to the laboratory, always covered in moist earth, never exposed, and incubated in a manner we shall presently describe.

Another expedient was also adopted. Gravid females were caught alive and brought to the laboratory. They were not chloroformed; their abdomens were cut open. Having exposed the oviducts, ripe, shelled eggs were quickly detached from the walls of the oviduct and as quickly embedded in moist, sandy earth kept ready in small boxes.

These eggs as well as the eggs naturally laid and collected from outside, all carefully timed and labelled, were left embedded in ordinary soil. Moist rather sandy earth was used, three to six inches deep in ordinary wooden boxes. These boxes were left on the window sills of the laboratory room exposed throughout to diffused sun light entering the room through large, glass-pane windows. Every twenty-four hours, in the early stages, enough water was sprinkled on the earth containing the eggs to keep it moist. At regular intervals, 12, 24, 48, 72 hours, one or two eggs were opened and the required stages of the embryos fixed. On all cases, without a single exception, embryos were perfectly fresh and active with pulsating heart and deep red, healthy blood. In the course of three or four breeding seasons not once have we seen an egg giving an embryo anyway decomposed or disorganized, unhealthy or shrunken. Nor have we seen any difference in the development and subsequent behaviour between the eggs naturally laid and collected from the wild and those derived from the oviducts of the females operated upon in the laboratory. Many series of eggs were left undisturbed to hatch out; and in all cases at the expected time on the completion of the incubation period there emerged plump, healthy-looking young from all those eggs incubated in the laboratory in the manner described above. The majority of the eggs that have been thus treated in our laboratory hatched after a period not less than 42 nor more than 45 days.

A day or two before hatching, at one end of the egg there appears a small dark patch on the now dirty-white shell, 3 mm. in diameter. At the time of hatching this spot tears in the middle with three or four radiating slits which, however, do not extend much beyond

this slightly darkened area. First emerges the snout then the head. In about half an hour from the appearance of the tear, the young is free from the shell.

The period of attaining Sexual Maturity after hatching :—By prolonged observations and carefully controlled experiments we have determined that amidst natural conditions the young of *Calotes* become sexually mature nine to twelve months after they emerge from the eggs. In other words, the young that are hatched at the close of a particular breeding season become parents and lay eggs in the succeeding breeding season.

Taking the smallness of size as a reliable criterion of sexual immaturity we began collecting from the field at the close of a breeding season the smallest-sized individuals every fortnight or at shorter intervals. Of course, it was assumed that the smallest-sized individuals were the products of the eggs hatched in that breeding season. Thus a series of all small-sized individuals from October to May was obtained. The organs of reproduction of these small-sized individuals were examined as these were collected from time to time, and these organs were compared with those of large, undoubtedly matured individuals more than one year old. From October to about the end of February little or no difference was noted in the size, growth and activity of the gonads of both kinds of individuals large, undoubted adults, and the small-sized individuals regarded as sexually immature. But on the approach of the breeding season, March, April and May, there was the same characteristic sudden growth and activity in the gonads of the smallest-sized individuals as in those of the larger ones. Though the external body size of the two groups of individuals differed, there was little difference in the growing dimensions of their ovaries and testes.

In order to test the validity of this hypothesis and confirm the observations already made, the following expedient was adopted. A large number of freshly laid eggs, including one or two series derived from the oviducts of the operated, gravid females, was incubated in the laboratory as before. Fifty to sixty young *Calotes* thus hatched in the laboratory were set free in the college compound and in a neighbouring field. This plan was devised with a view to finding out whether the specimens thus set free, would grow amidst natural conditions, attain sexual maturity and could be recovered as sexually matured individuals in the succeeding breeding season. In order to mark these young ones, so that the same specimens may subsequently be recognized when captured from the field on the approach of and during the succeeding breeding season we amputated their toes. Some young had the innermost toes of both their anterior limbs cut off with proper antiseptic precautions. Other specimens were deprived of their outermost toes of each of the hind-limbs. In other individuals other toes were cut off. In this way the young specimens, which had hatched in our laboratory a few hours before, were variously marked; their records were kept in a note book and they were set free during August and September last year.

The experiment has been successful. Though an intensive search has not been made to recover all or most of these marked specimens

left off last August and September, so far we have recovered five of these. All have grown to a large size. The mutilated toes are not regenerated; they are missing. It so happens that each of these five specimens is a representative of each of the five series differently marked. One has the innermost toe of both its anterior limb missing, while in an other specimen the outer toes of the hind-limbs are wanting. The third one had been deprived of the outermost toes of its right hind-limb, and it is not there. The gonads of all are large, fully-developed and matured.

The most convincing example, however, is a grown up, gravid female. In each of her two oviducts there are fully-matured, large, shelled, white eggs ready to be laid. As recorded in our notes, she is one of a series of young ones that hatched in the laboratory between 7 p.m. of September 5, and 9 a.m. of September 8, 1929. When recovered from the college compound and killed at 4 p.m. on July 11, 1930, she was about ten months and three to six days old.

This leaves no doubt that the young of *Calotes versicolor* attain sexual maturity nine to twelve months after they have emerged from the eggs. The young that have hatched in a particular breeding season grow to be parents and lay eggs in the succeeding breeding season.

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